OBSTETRICS

Exercise during pregnancy protects against hypertension and macrosomia: randomized clinical trial

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BACKGROUND: The prevalence of all pregnancies with some form of hypertension can be up to 10%, with the rates of diagnosis varying according to the country and population studied and the criteria used to establish the diagnosis. Prepregnancy obesity and excessive gestational weight gain (GWG) of all body mass index (BMI) categories have been associated with maternal hypertensive disorders and linked to macrosomia (>4000 g) and low birthweight (<2500 g). No large randomized controlled trial with high adherence to an exercise program has examined pregnancy-induced hypertension and these associated issues. We investigated whether women adherent (≥80% attendance) to an exercise program initiated early showed a reduction in pregnancy-induced hypertension and excessive GWG in all prepregnancy BMI categories, and determined if maternal exercise protected against macrosomia and low birthweight.

OBJECTIVE: We sought to examine the impact of a program of supervised exercise throughout pregnancy on the incidence of pregnancy-induced hypertension.

STUDY DESIGN: A randomized controlled trial was used. Women were randomized into an exercise group (N = 382) or a control group (N = 383) receiving standard care. The exercise group trained 3 d/wk (50-55 min/session) from gestational weeks 9-11 until weeks 38-39. The 85 training sessions involved aerobic exercise, muscular strength, and flexibility.

RESULTS: High attendance to the exercise program regardless of BMI showed that pregnant women who did not exercise are 3 times more likely to develop hypertension (odds ratio [OR], 2.96; 95% confidence interval [CI], 1.29−6.81, $P = .01$) and are 1.5 times more likely to gain excessive weight if they do not exercise (OR, 1.47; 95% CI, 1.06−2.03, $P = .02$). Pregnant women who do not exercise are also 2.5 times more likely to give birth to a macrosomic infant (OR, 2.53; 95% CI, 1.03−6.20, $P = .04$).

CONCLUSION: Maternal exercise may be a preventative tool for hypertension and excessive GWG, and may control offspring size at birth while reducing comorbidities related to chronic disease risk.

Key words: exercise, gestational weight gain, hypertension, intervention, outcome, pregnancy

Introduction

The prevalence of all pregnancies with some form of hypertension can be up to 10%,[1] with the rates of diagnosis varying according to the country and population studied and the criteria used to establish the diagnosis.[2] Although these clinical issues may range in severity from trivial to life threatening,[1] elevated blood pressure (BP) remains the leading cause of maternal, fetal, and neonatal morbidity and mortality.[2,3] Gestational hypertension has been defined as elevated BP[4] that develops >20 weeks of gestation in a previously normotensive woman, without proteinuria.[1] These women are at high risk (15-45%) for developing preeclampsia[1] with high BP,[5] typically appearing >20 weeks of pregnancy in a normotensive woman, and most frequently including proteinuria.[2] Preeclampsia may or may not progress to eclampsia with the occurrence of seizures and extreme maternal and fetal complications.[5] Severity of symptoms can accelerate rapidly, leading to immediate delivery regardless of gestational age.[5] Although the origin of pregnancy hypertension is unknown,[6] many theories exist suggesting that the pathophysiological processes that lead to preeclampsia begin in early pregnancy, even though maternal symptoms do not appear until mid to late gestation.[7]

Although the causal link to pregnancy-induced hypertension is unknown, there are maternal factors, such as excessive gestational weight gain (GWG) regardless of prepregnancy body mass index (BMI), and maternal obesity[8] that increase the risk for hypertensive disorders.[9] In addition, there are downstream consequences of pregnancy-induced hypertension that have been linked to neonatal birthweight (macrosomia >4000 g; low birthweight <2500 g),[10] leading to childhood obesity and cardiovascular disease risk in the offspring.[10] It has been suggested that interventions focus on reducing modifiable risk factors (one of the most prominent being excessive GWG) should be incorporated into prenatal care to improve the health of the mother and reduce perinatal complications[11] and cardiovascular risk.

Epidemiological evidence suggests that women who participate in regular physical activity have a reduced risk of developing pregnancy-induced hypertension[12] and preeclampsia.[13-15] These studies are based on retrospective questionnaires in case-control cohorts and, as recent reviews concluded, there is a critical need for well-designed randomized controlled trials (RCT).[16-18] The aim of the present study was to examine the impact of a program of supervised exercise throughout pregnancy on the incidence of pregnancy-induced hypertension. We hypothesized that adherent women (≥80% attendance) to an exercise program initiated early in pregnancy (9-11 weeks' gestation) will have a decreased incidence of pregnancy-

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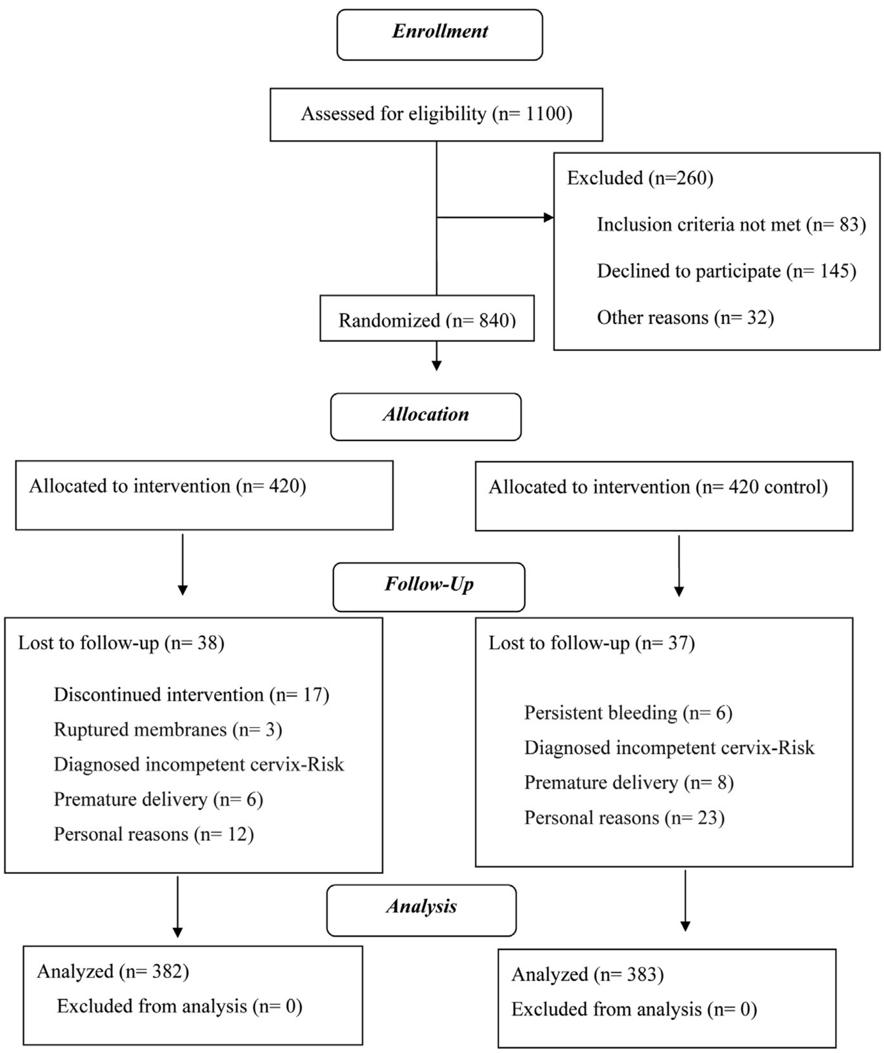
FIGURE
Consolidated Standards Of Reporting Trials (CONSORT) 2010 flow diagram of study participants



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induced hypertension and that exercise will protect against the initiation of this disease in women of all prepregnancy BMI categories, while also protecting against excessive GWG. In addition, we hypothesized that exercise protects against macrosomia (>4000 g) and low birthweight (<2500 g) and other pregnancy complications.

Materials and Methods

The present RCT (identifier: NCT01723098) was conducted from December 2011 through January 2015 following the ethical guidelines of the Declaration of Helsinki, last modified in 2000. The research protocol was reviewed and approved by the ethics review board of Hospital Severo Ochoa (Madrid, Spain). The onset of patient enrollment was November 2012.

Participants and randomization

A total of 1100 Spanish-speaking (Caucasian) pregnant women from primary care medical centers (Figure) were assessed for eligibility. Women with singleton and uncomplicated pregnancies (no type 1, type 2, or gestational diabetes mellitus [GDM] at baseline) with no history or risk of preterm delivery were included. Women not planning to give birth in the same obstetric hospital and not under medical follow-up throughout pregnancy were not included in the study, neither were women having any serious medical conditions (contraindications) that prevented them from exercising safely.[19]

After women provided written informed consent, 840 healthy gravidae were randomized (ratio 1:1) to either an exercise intervention (n = 420) or usual care (n = 420) group. The participant randomization assignment followed an allocation concealment process using a random numbers table. Assessment staff members were blinded to assignment. The randomization process (sequence generation, allocation concealment, and implementation) was conducted by 3 different individuals. To reduce participant drop out and to maintain adherence to the training program, all sessions were accompanied with music, and were performed in an air-conditioned well-lit exercise room at the hospital. A qualified fitness specialist carefully supervised every training session with the assistance of an obstetrician.

Exercise intervention

The randomization was performed in waves so that each wave had between 10-12 participants in the exercise group, and 10-12 women in the control group. The exercise group trained 3 d/wk (50-55 min/session), from weeks 9-11 of pregnancy, to the end of the third trimester (weeks 38-39). An average of 85 training sessions was originally planned for each participant in the event of no preterm delivery. The intervention involved aerobic exercise, aerobic dance, muscular strength, and flexibility, and met the standards of the American Congress of Obstetricians and Gynecologists.[19] Women used a heart rate monitor (Accurex Plus; Kempel, Finland) during the training sessions (heart rate was consistently <70% of age-predicted maximum) and the rating of perceived exertion scale ranged from 12-14 (somewhat hard).[20]

Each exercise session was preceded and followed by a gradual warm-up and cool-down period (both 10-12 minutes' duration) and consisted of walking and light static stretching of most muscle groups. The cool-down period included relaxation and pelvic floor exercises.

The main exercise session (25-30 minutes) included moderate resistance exercise performed through the full range of motion and engaged major muscle groups (pectoral, back, shoulder, upper and lower limb muscles). One set (10-12 repetitions) was conducted using barbells (2 kg/exercise) or low-to-medium resistance (elastic) bands (Therabands, Hygenic Corp., Catalonia, Spain). Exercises in the supine position were not performed for >2 minutes.

Usual care (control) group

Women randomly assigned to the control group received general advice from their health care provider about the positive effects of physical activity. Participants in the control group had their usual visits with health care providers during pregnancy, which were equal to the exercise group. Women were not discouraged from exercising on their own. However, women in the control group were asked by telephone about their exercise once each trimester using a decision algorithm.

Question 1: Since the beginning of pregnancy, have you exercised in your leisure time, in a supervised program, or on your own?

a. Answer: No.
b. Answer: Yes.

Question 2 (if the previous response was "b"): Given 7 days a week, how many days per week did you exercise?

a. Answer: <3 days.
b. Answer: ≥3 days.

Question 3 (if the previous response was "b"): Taking into account the total duration of physical exercise continuously, how long did you exercise every day?

a. Answer: <20 minutes each day.
b. Answer: ≥20 minutes each day.

Interpretation of the decision algorithm: Pregnant women in the control group who reached level "b" of these 3 questions were excluded from the study.

Participant demographics

Demographic and other information (pregravid weight and height), parity, occupational activity, previous physical activity habits, smoking status, previous preterm birth, and previous miscarriage were obtained at the first prenatal visit either by reviewing the medical records or by questionnaire. Inclusion/exclusion criteria were determined at this initial visit by the attending obstetrician.

Outcomes

Primary outcome

Diastolic and systolic arterial BP were measured at every visit to the obstetrician as part of standard care (once each trimester) and were obtained from medical records. Criteria for measuring BP[3] were as follows:

1) Measured in the sitting position with the arm at the level of the heart using an appropriately sized cuff;
2) Korotkoff phase V was used to designate diastolic BP;
3) Diagnosis of hypertension was defined as a diastolic BP of ≥90 mm Hg and a systolic BP ≥140 mm Hg,[4] based on the average of at least 2 measurements, using the same arm and recorded in the medical file.

The primary outcome was the number (percentage/incidence) of women who developed hypertension during pregnancy.

Secondary outcomes

Total GWG was calculated on the basis of the weight at the last clinic visit before delivery minus the pregravid weight (from hospital records) and stratified by prepregnancy BMI categories based on the Institute of Medicine (IOM) guidelines.[21] Excessive body weight gain was determined by IOM guidelines[21] for prepregnancy BMI categories for each woman: >18 kg for underweight; >16 kg for normal weight; >11.5 kg for overweight; and >9 kg for obese. Diagnosis of GDM was also included from medical records.

Birthweight was recorded from hospital perinatal records. Newborns were classified as having macrosomia when birthweight was >4000 g and low birthweight was defined as <2500 g.[22] We obtained other maternal and fetal outcomes from the medical records.

Statistical analysis

Power calculations for the primary outcome (diagnosis of hypertension)[23,24] used a prevalence of ∼4% in the intervention group and 10% in the usual care group. Under these assumptions, a 2-sample comparison (χ^2) with a 5% level of significance and a statistical power of 0.90 gave a study population of 378 patients in each group. Assuming a maximum lost to follow-up of 10%, approximately 416 women were needed for each group at baseline.

For treatment group comparisons, we analyzed continuous and nominal data with a Student *t* test for unpaired data and χ^2 tests, respectively. We used logistic regression analysis to examine the interaction between study group (training and control) on the likelihood of developing hypertension (primary outcome), gaining excessive gestational weight (secondary outcome), developing GDM (secondary outcome), delivering a preterm infant (secondary outcome), and modifying other pregnancy outcomes (length of newborn, Apgar scores at 1 and 5 minutes after delivery, and cord blood pH; secondary outcomes) as separate endpoints after controlling for maternal age, parity, smoking status, occupational activity during pregnancy, prepregnancy exercise habits, and prepregnancy BMI. We also used logistic regression analysis to examine the interaction between study group (training and control) and birthweight categories as separate endpoints on the probability of having a newborn with macrosomia (>4000 g) and on the likelihood of having a low-birthweight (<2500 g) infant (secondary outcomes) after the same adjustment. We conducted statistical analyses using software (SPSS, Version 18.0; IBM Corp, Armonk, NY, and SAS, Version 9.3; SAS Institute, Cary, NC). The level of significance was set to ≤.05.

Results

A total of 840 pregnant women met the criteria. After randomization, 38 women

TABLE 1
Characteristics of exercise and control (usual care) groups at study entry

	Control (n = 383)	Exercise (n = 382)
Maternal characteristics		
Maternal age, y	31.8 ± 4.5	31.6 ± 4.2
BMI, kg/m^2	23.4 ± 4.2	23.6 ± 3.8
Blood pressure, mm Hg		
Systolic	113.9 ± 13.8	113.5 ± 11.8
Diastolic	67.5 ± 10.2	68.0 ± 8.4
BMI categories, n/%		
Underweight	20/5.2	10/2.6
Normal weight	259/67.6	258/67.5
Overweight	75/19.6	89/23.3
Obese	29/7.6	25/6.5
Occupational activity, n/%		
Sedentary job	148/38.6	171/44.8
Homemaker	93/24.3	72/18.9
Active job	142/37.1	139/36.4
Previous physical activity habits, n/%		
Active	70/18.3	61/16.0
Sedentary	313/81.7	321/84.0
Parity, n/%		
None	229/59.8	259/67.8
1	127/33.2	100/26.2
≥2	27/7.1	23/6.0
Smoking during pregnancy, n/%		
Yes	54/14.1	40/10.5
No	329/85.9	342/89.5
Previous miscarriage, n/%		
None	279/72.9	301/78.8
1	90/23.5	70/18.3
≥2	14/3.7	11/2.9

There are no statistical differences between groups at baseline ($P > .05$). Data are expressed as mean SD, unless otherwise indicated.

BMI, body mass index.

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in the exercise group were lost to follow-up because of discontinued intervention (N = 17), ruptured membranes (N = 3), diagnosed incompetent cervix, obstetric risk of premature delivery (n = 6), and personal reasons (N = 12). In all, 37 participants in the control group were excluded from the study because of persistent bleeding (n = 6), diagnosed incompetent cervix, obstetric risk of premature delivery (n = 8), and personal reasons (N = 23). A final total of 765 pregnant women were analyzed with 382 in the exercise group and 383 in the control group (Figure).

Maternal characteristics

Personal data were collected from all participants at the beginning of the study as is shown in Table 1. No statistical differences were found between groups.

Hypertension and other pregnancy outcomes

In the exercise vs control groups, exercise reduced the incidence of hypertension (2.1% vs 5.7%, $P = .009$), preeclampsia (0.5% vs 2.3%, $P = .03$), and GDM (2.4% vs 5.5%, $P = .03$), respectively, in all women (Table 2). Exercise also prevented excessive maternal weight gain (26.4% vs 34.2%, $P = .03$, respectively) based on prepregnancy BMI[21] compared to the control women. Overall, the exercising women gained less weight than the control women (12.1 ± 3.7 vs 12.9 ± 4.5 kg, $P = .01$, respectively). There were no differences between the groups with regards to gestational age, type of delivery, birthweight, length, head circumference, Apgar scores (1 and 5 minutes, expressed as the number of babies with ≥7), or umbilical cord blood pH, $P > .05$. When birthweight was stratified by birthweight categories, exercise decreased the number of macrosomic babies ($P = .03$) while increasing the number of adequate-weight babies ($P = .01$) compared to the control group. There was no change in the number of babies born small ($P = .15$). When stratified by prepregnancy BMI category (Table 3) exercise reduced the incidence of hypertension ($P = .02$), and prevented excessive GWG ($P = .01$) and GDM ($P = .03$) compared to control women. Exercise did not change preterm delivery when stratified by BMI categories. When newborn birthweight categories were stratified by maternal prepregnancy BMI categories, the incidence of macrosomia was reduced ($P = .03$) (Table 3). The incidence of low-birthweight babies did not change in any of the maternal BMI categories as a result of exercise. Interestingly, when we stratified by parity categories (none, 1, or ≥2) (Table 4), being nulliparous was a determining factor for the presence of hypertension (odds ratio [OR], 0.32; 95% confidence interval [CI], 0.11−0.93, $P = .02$) and preterm delivery (OR, 0.51; 95% CI, 0.26−0.98, $P = .04$) in women who did not exercise. Furthermore, women who had ≥2 pregnancies and did not exercise

TABLE 2
Effect of exercise on hypertension and other pregnancy outcomes in all participants

	All (n = 765)		
	Control (n = 383)	Exercise (n = 382)	*P*
Maternal hypertension, n/%	22/5.7	8/2.1	.009
Preeclampsia, n/%	9/2.3	2/0.5	.03
Maternal weight gain, kg	12.9 ± 4.5	12.1 ± 3.7	.01
Excessive maternal weight gain, n/%	131/34.2	101/26.4	.03
Gestational diabetes, n/%	21/5.5	9/2.4	.03
Gestational age, d	276.0 ± 13.0	277.3 ± 12.2	.11
Preterm delivery, <37 wk, n/%	37/9.7	29/7.6	.31
Type of delivery, n/%			
Normal	236/61.6	260/68.1	.06
Instrumental	64/16.7	49/12.8	.13
Cesarean	83/21.7	73/19.1	.38
Newborn			
Birthweight, g	3218 ± 453	3252 ± 438	.29
Birthweight categories, g, n/%			
Adequate 2500–4000	340/88.8	359/94	.01
Low <2500	25/6.5	16/4.2	.15
Macrosomia >4000	18/4.7	7/1.8	.03
Birth length, cm	49.8 ± 2.1	50.0 ± 2.2	.11
Head circumference, cm	34.5 ± 1.5	34.4 ± 1.3	.47
Apgar score 1 min			
≥7, n/%	359/93.7	366/95.8	.19
Apgar score 5 min			
≥7, n/%	380/99.2	381/99.7	.31
pH of umbilical cord blood	7.28 ± 0.07	7.28 ± 0.07	.46

Data are expressed as mean ± SD, unless otherwise indicated. We analyzed continuous and nominal data with Student *t* test for unpaired data and χ^2 analyses, respectively.

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may gain excessively (OR, 0.30; 95% CI, 0.09–1.04, *P* = .053).

Logistic regression analysis

With the endpoint as hypertension, after controlling for maternal age, parity, smoking status, occupation, activity prepregnancy, and prepregnancy BMI, pregnant women who did not exercise were 3 times more likely to develop hypertension during pregnancy (OR, 2.96; 95% CI, 1.29–6.81, *P* = .01). With the endpoint as excessive GWG, pregnant women were 1.5 times more likely to gain excessive weight if they did not exercise (OR, 1.47; 95% CI, 1.06–2.03, *P* = .02). With GDM as the endpoint, women were 2 times more likely to develop GDM if they did not exercise during pregnancy, but this was not significant (OR, 2.05; 95% CI, 0.91–4.6, *P* = .08). After screening for preterm delivery risk factors (exclusion criteria before randomization), preterm delivery incidence was not different between groups, however, women were 1.3 times more likely to deliver a preterm infant if they did not exercise (OR, 1.31; 95% CI, 0.78–2.19, *P* = .34). Other variables investigated that were not different between groups included length of newborn, Apgar scores at 1 and 5 minutes after delivery, and cord blood pH. However, pregnant women were 2.5 times more likely to give birth to a macrosomic infant (OR, 2.53; 95% CI, 1.03–6.20, *P* = .04) if they did not exercise during pregnancy, and although not significant, these women were also 1.6 times more likely to deliver a low-birthweight baby (OR, 1.6; 95% CI, 0.83–3.09, *P* = .15).

Comment

We examined the effects of physical training during pregnancy on the incidence of pregnancy-induced hypertension regardless of prepregnancy BMI. This novel approach used an integration of light resistance, toning, aerobic dance, and pelvic floor exercises in the training program, easily incorporated into a structured exercise regime. It appears that this program was equally liked by all BMI categories as indicated by the high adherence rate.

Interventions focusing on reducing modifiable risk factors (one of the most prominent being excessive GWG) should be incorporated into prenatal care to improve the health of the mother and reduce perinatal complications and cardiovascular risk.[11] Our exercise intervention reduced the incidence of hypertension (3 times more likely) and prevented excessive GWG (1.5 times more likely), without changing gestational age, the incidence of preterm delivery, and method of delivery compared to standard-care women after controlling for confounding factors. Regardless of prepregnancy BMI, exercise also reduced the incidence of macrosomia (by 2.5 times) and protected against low-birthweight infants.

Pregnancy-induced hypertension has no known cause but it is thought to develop early in gestation with symptoms occurring in mid to late pregnancy,[7] and may be a precursor to the development of preeclampsia.[7,9] Although preeclampsia was not our primary outcome, the number of women who developed this disease was

TABLE 3
Effect of exercise on hypertension and other pregnancy outcomes by prepregnancy body mass index categories

	Body mass index categories								
	Underweight		Normal weight		Overweight		Obese		
Variable	Control (n = 20)	Exercise (n = 10)	Control (n = 256)	Exercise (n = 257)	Control (n = 78)	Exercise (n = 90)	Control (n = 29)	Exercise (n = 25)	*P*
Maternal hypertension	0	0	15/5.9	2/0.8	6/7.7	4/4.4	1/3.5	2/8.0	.02
Excessive maternal weight gain	4/20.0	1/10.0	71/27.7	39/15.2	41/52.6	50/55.6	15/51.7	11/44.0	.01
Gestational diabetes	3/15.0	0	13/5.1	6/2.3	4/5.1	2/2.2	1/3.5	1/4.0	.03
Preterm delivery, <37 wk	1/5.0	0	21/8.2	19/7.4	13/16.7	7/7.8	2/6.9	3/12.0	.31
	Newborn birthweight categories								
Adequate 2500–4000 g	18/90.0	8/80.0	232/90.6	240/93.4	63/80.8	88/97.8	27/93.1	23/92.0	.01
Low <2500 g	2/10.0	1/10.0	14/5.5	12/4.7	7/9.0	2/2.2	2/6.9	1/4.0	.15
Macrosomia >4000 g	0	1/10.0	10/3.9	5/1.9	8/10.3	0	0	1/4.0	.03

Data are expressed as n/%, unless otherwise indicated. *P* values are based on χ^2 analyses.

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lowered by the exercise intervention. If an exercise program started early in gestation in asymptomatic low-risk women prevented hypertension (and potentially preeclampsia), which may be linked to excessive GWG, then a healthy lifestyle initiated preconception and in early gestation may perhaps be the key issues to preventing chronic disease risk in both mother and baby. Epidemiological studies suggest that women who are physically active are less likely to develop gestational hypertension, based on retrospective questionnaires, and none examined the interaction of exercise and prevention of excessive GWG.[12-15] We believe we are the first to link an early exercise intervention with high adherence and prevention of excessive weight gain to reducing the incidence of maternal chronic disease risk (hypertension and GDM). In any RCT examining the effects of an exercise program, high adherence and early prevention of excessive GWG may be the key issues to the efficacy of the trial.

Maternal exercise has many benefits and has been associated with lowering of BP[25] and an increase in aerobic and cardiovascular conditioning.[26] Engaging in exercise may be particularly important for nulliparous women, as we found the incidence of hypertension and preterm delivery was reduced in our first-time pregnant women. Exercise may also protect against preeclampsia by reducing maternal byproducts of oxidative stress, preventing endothelial dysfunction, and stimulating vascularity and placental growth.[27] Furthermore, exercise has been shown to reduce excessive GWG in normal-weight,[28,29] overweight, and obese women,[30] and to improve maternal health perception[31] and mood.[32,33] Women with ≥2 pregnancies may also benefit from maternal exercise because our results would suggest that these women may be more susceptible to excessive GWG than women with fewer pregnancies. In addition, exercise has been linked to beneficial fetal and pregnancy outcomes.[34-36] Our large RCT confirms that a healthy lifestyle intervention with high adherence that prevents excessive GWG may indeed provide a healthy environment to prevent future chronic disease risk in both mother and offspring. Excessive GWG, macrosomia, and low-birthweight babies have been linked with childhood obesity[37-40] and other offspring chronic disease risks, including cardiovascular disease.[41]

Strengths and weaknesses

The major strengths of our study are the large RCT with high adherence (≥80% attendance) in our exercise group and the ability to identify those women in the control group who did not remain sedentary built into the study design. Interestingly, none of the control women were excluded. It may be that without an exercise intervention and weekly accountability, few pregnant women will continue exercising on their own. One limitation of our study is that we did not assess nutrition or energy intake, however, all women had standard care and information regarding a healthy lifestyle during pregnancy, as the only difference between the 2 groups was the initiation of the exercise program. In addition, we did not assess occupational job stress in our participants, which may also be linked to baby size at birth[42] although we did control for occupation.

A potential weakness may be the utility and applicability of our findings to other clinical settings. However, it was our intent to offer this exercise program within a hospital setting, with "buy-in" from the hospitals involved. Many pregnant women do not engage in physical activity unless advised by their physician/obstetrician to do so and with an intervention placed within the hospital setting, our intervention women were motivated to attend at least 80% of the offered sessions. Because of the success of our program, perhaps more

TABLE 4
Effect of exercise on hypertension and other pregnancy outcomes stratified by parity categories (none, 1, ≥2)

n/%	All (n = 765) Control (n = 383)	Exercise (n = 382)	*P*
Maternal hypertension			
None	13/5.7	5/1.9	.03[a]
1	5/3.9	2/2.0	.40
≥2	4/14.8	1/4.3	.22
Excessive maternal weight gain			
None	72/31.4	71/27.4	.33
1	46/36.2	25/25.0	.07
≥2	13/48.1	5/21.7	.053[b]
Gestational diabetes			
None	10/4.4	5/1.9	.12
1	8/6.3	3/3.0	.25
≥2	3/11.1	1/4.3	.38
Preterm delivery, <37 wk			
None	26/11.4	16/6.2	.04[c]
1	6/4.7	10/10.0	.12
≥2	5/18.5	3/13.0	.60

[a] Odds ratio, 0.33; 95% confidence interval, 0.12—0.93; [b] Odds ratio, 0.30, 95% confidence interval, 0.09—1.04; [c] Odds ratio, 0.51, 95% confidence interval, 0.27—0.99.

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clinics and hospital settings should adopt this type of exercise presentation to make a difference in the health and potential disease risk of their pregnant patients.

Our large RCT with high adherence for all prepregnancy BMI categories strongly advocates the role of maternal exercise started early in pregnancy in reducing the risk of pregnancy-induced hypertension, excessive GWG, and macrosomic infants while protecting against having a low-birthweight baby. Put another way, without exercise during pregnancy, women are 3 times more likely to develop hypertension, 1.5 times more likely to gain excessive weight, and 2.5 times more likely to give birth to a macrosomic infant. Assessment of the exercise activity of the control group and evaluation of adherence (attendance) to a prenatal exercise program must be considered when examining the effects of RCTs because without high adherence to the program being assessed, and exclusion of highly active women in the control group, examination of the primary outcome provides little relevant information to clinical practice. Further research is required to determine if adding controlled nutrition in combination with an exercise program initiated early in pregnancy will be efficacious in routine clinical practice to reduce the incidence of hypertension, its comorbidities including future cardiovascular disease, and obesity risks in pregnant women and the next generation. ■

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